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A Holistic Scenario of Turbulent Molecular Cloud Evolution and Control of the Star Formation Efficiency. First Tests

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abstract We compile a holistic scenario for molecular cloud (MC) evolution and control of the star formation efficiency (SFE), and present a first set of numerical tests of it. A *lossy* compressible cascade can generate density fluctuations and further turbulence at small scales from large-scale motions, implying that the turbulence in MCs may originate from the compressions that form them. Below a *sonic* scale , turbulence cannot induce any further subfragmentation, nor be a dominant support agent against gravity. Since progressively smaller density peaks contain progressively smaller fractions of the mass, we expect the SFE to decrease with decreasing , at least when the cloud is globally supported by turbulence. Our numerical experiments confirm this prediction. We also find that the collapsed mass fraction in the simulations always saturates below 100% efficiency. This may be due to the decreased mean density of the leftover interclump medium, which in real clouds (not confined to a box) should then be more easily dispersed, marking the "death" of the cloud. We identify two different functional dependences ("modes") of the SFE on , which roughly correspond to globally supported and unsupported cases. Globally supported runs with most of the turbulent energy at the largest scales have similar SFEs to those of unsupported runs, providing numerical evidence of the dual role of turbulence, whereby turbulence, besides providing support, induces collapse at smaller scales through its large-scale modes. We tentatively suggest that these modes may correspond to the clustered and isolated modes of star formation, although here they are seen to form part of a continuum rather than being separate modes. Finally, we compare with previous proposals that the relevant parameter is the energy injection scale.